

*A GIGANTIC "PLEASURING GROUND": THE
YELLOWSTONE NATIONAL PARK OF THE
UNITED STATES*

THE Americans do their pleasuring as gigantically as they do everything else. This is the first and strongest impression made upon one by an Act of Congress of March 1872, to which we alluded in a recent number of *NATURE*, enacting that a district about half the size of Wales, and 1,000 square miles larger than the largest Swiss Canton, be "dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people." It is forbidden that anyone shall hereafter settle upon or enclose any part of the immense area thus set apart, and only such buildings can be erected upon it as the Secretary of the Interior, who has the exclusive control of this "park" (what an inadequate

name!), may deem conducive to the accommodation and comfort of the visitors.

The estimated extent of the district thus set apart is 3,575 square miles, and coincides to a large extent with the area contained between the 110th and 111th degree of W. long., and the 44th and 45th parallels of N. lat. The southern boundary, however, is about eight miles farther north than and parallel with the 44th degree, and about seven miles westward of and parallel with the 111th degree, the whole district forming very nearly a square, and looking on the map like a huge slice out of one of the most mountainous parts of Switzerland; one of the heights, Mount Washburne, is 10,575 feet above sea level. Even the lowest part toward the south, containing the basin of Yellowstone Lake (330 square miles), "one of the most beautiful lakes of the world," is about 7,000 feet above the sea. Besides the huge mountains that form the most prominent features of this pleasure ground, the

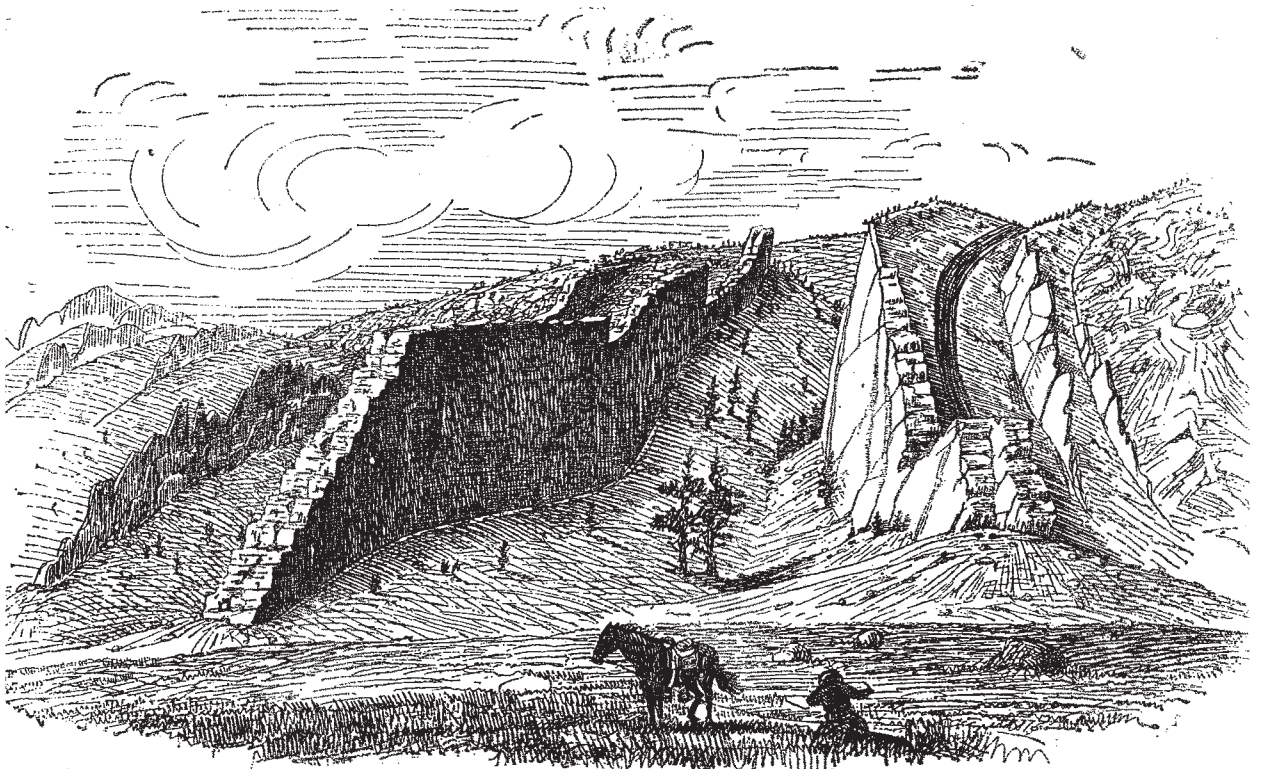


FIG. 1.—Natural Walls in Yellowstone Park.

beautiful lake just mentioned, and a large part of the upper courses of the picturesque Yellowstone and other rivers, the district embraces some of the most remarkable natural phenomena that are to be seen in any part of the world—wonderful falls, multitudes of hot springs, steam springs, mud geysers, mud puffs, water geysers, some of them rising to a height of 200 feet, and other objects of interest. This whole region was in comparatively modern geological times the scene of wonderful volcanic activity. The hot springs, geysers, &c., represent the last stages, the vents or escape pipes, of these remarkable volcanic manifestations. All these hot springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands of years for the cunning hand of Nature to form. The geysers of Iceland sink into insignificance in comparison with the hot springs of the Yellowstone and Fire-hole basin. No por-

tion of this tract could ever be made available for mining or agricultural purposes. The mountains that wall it in on every side form one of the most remarkable watersheds on the continent. From whatever point of view we survey this remarkable region, it is unsurpassed in interest, and the Act is one that should cause universal satisfaction throughout the States. "This noble deed," Mr. F. V. Hayden truly says, "may be regarded as a tribute from our legislators to science, and the gratitude of the nation, and of men of science in all parts of the world, is due to them for this munificent donation."

Several exploring parties have lately visited the district, and from an account of one of these, under Mr. F. V. Hayden, U.S. Geologist, to whose courtesy we are indebted for the accompanying woodcuts, we condense the following description of some of the most remarkable phenomena to be witnessed.

Nine-tenths of the area is covered with volcanic material in some form. The base rocks are the usual metamorphic granitoid series of the country, with basalts and basaltic conglomerates in every variety. The sedimentary rocks belong to the Carboniferous, Jurassic, Cretaceous, and Tertiary ages. The Triassic is probably wanting. The sedimentary rocks occur in patches, covering very restricted areas, yet presenting evidence that, up to the period of the Eocene Tertiary inclusive, they were extended uninterruptedly over the whole country. In the Yellowstone

valley, as in the valleys of all the streams of the West, there is a chain of lake basins that must have existed during the Pliocene period. There was a continuous chain of these lakes of greater or less size to the source of the river; thence it expanded into an immense double lake, of which only a remnant, Yellowstone Lake, now remains. This lake was once much larger than at present, and it was partially connected with another lake about 30 miles long and 20 wide, which terminated at the Grand Cañon, at the upper falls of the Yellowstone.

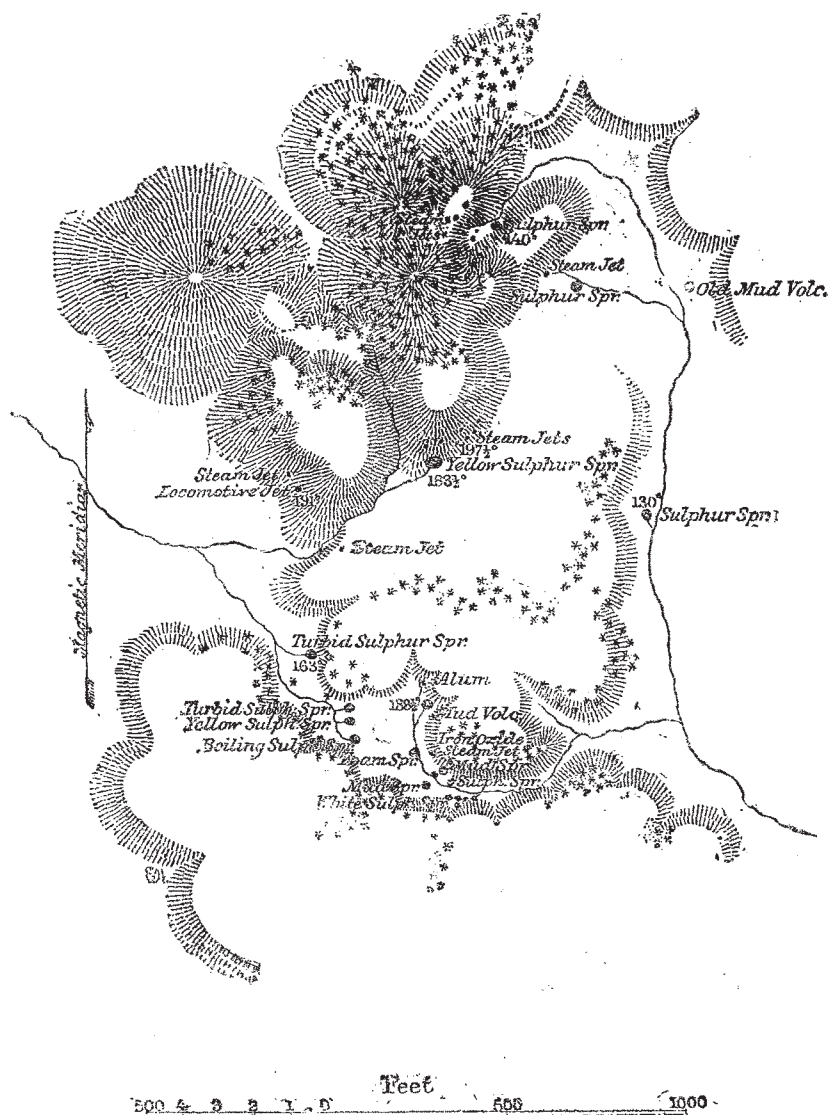


FIG. 2.—Sulphur and Mud Springs, Eight Miles below Yellowstone Lake.

The term Yellowstone Basin is sometimes applied to the entire valley; but the basin proper comprises only that portion enclosed within the remarkable ranges of mountains which give origin to the waters of the Yellowstone, south of Mount Washburne and the Grand Cañon. This basin is about 40 miles in length from north to south, and on an average 30 miles in width from east to west. It might be called the vast crater of an ancient volcano made up of thousands of smaller rents and fissures, out of which the fluid interior of the earth, fragments of

rocks, and volcanic dust have been erupted in unlimited quantities. Hundreds of the nuclei or cones of these volcanic rents are now remaining, some of them rising to a height of nearly 11,000 feet above the sea. Indeed, as has been said, the hot springs and geysers of this region are only the closing stages of that wonderful period of volcanic action which began in Tertiary times. Even at the present time there are connected with these manifestations of internal heat earthquake phenomena which are well worthy of attention. Earthquake shocks are not

uncommon, and are at some seasons of the year very severe.

Yellowstone Lake itself has at all seasons the temperature nearly of cold spring water, and its area is gradually but very slowly diminishing. Mr. Hayden estimates that since the period of volcanic activity the depth of the lake has been about 500 feet greater than at present, the shore line having then been high up on the sides of the surrounding mountains.

Warm springs are not uncommon in the valley of the lower Yellowstone, but the temperature is seldom higher than 60° or 80°. It is not until we reach Gardiner's River, a small branch flowing into the Yellowstone on the left side, opposite the third cañon, that the true hot springs commence in their full force. About three miles above its junction with the Yellowstone, the valley bottom is

covered with a thick calcareous crust, the deposits of hot springs which are now extinct; but flowing swiftly from beneath this crust is a stream of hot water six feet wide and two feet deep, with a temperature of 132°. A little distance farther up is a high hill, on the slope of which has been formed a system of terraces, each from 200 ft. to 300 ft. in height, and covered with a thick deposit of lime. On the ascent of the hill, about three-fourths of a mile from the river bottom, there is to be met with one of the most remarkable exhibitions of hot spring deposits that is to be seen in this land of wonders. In the distance it looks like a vast glacier of snow and ice, on which account it has been named the White Mountain. Indeed, the different terraces can be compared, for their wonderful beauty, only to a frozen cascade. The remains of once active springs are plainly visible;

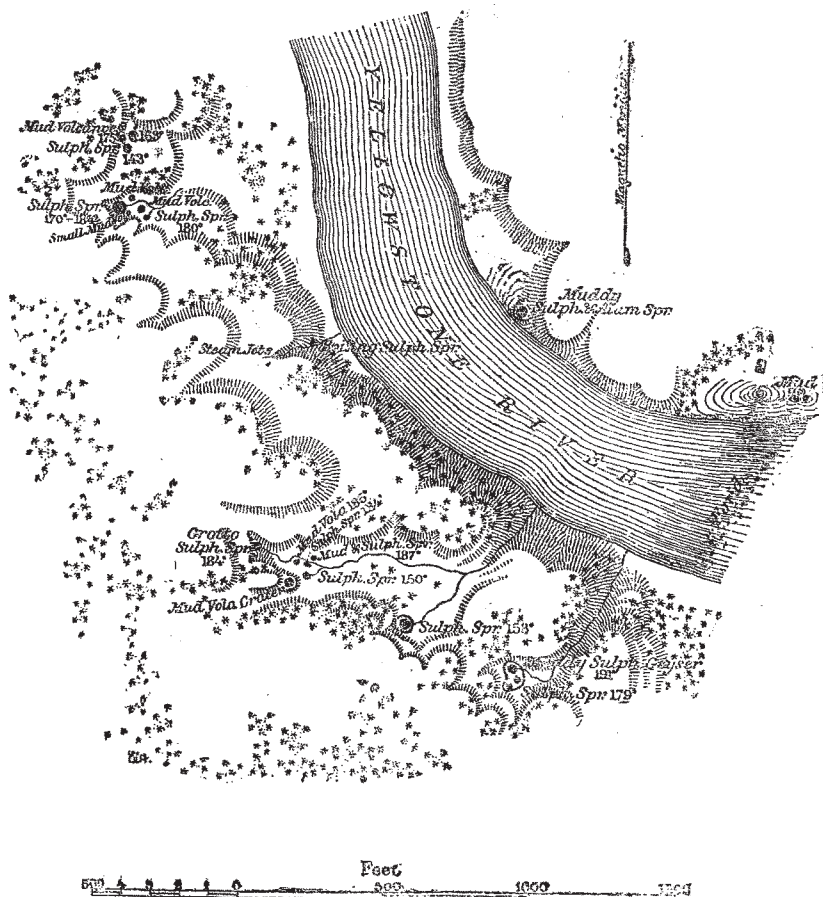


FIG. 3.—Sulphur and Mud Springs, Six Miles below the Lake.

old chimneys, irregular openings, like entrances to caverns, which extend beneath the crust, are numerous. This crust is probably from 20 ft. to 50 ft. in thickness, and underneath it is supposed that the surplus water from the active springs above flows down to the river. A little farther up is a series of basin-like pools, from 4 ft. to 8 ft. in diameter, and on a terrace about 200 ft. farther still are numbers of active springs, with basins 20 ft. to 50 ft. in diameter, some of them with several centres of violent ebullition in the same basin. The temperature at the outflow varies from 150° to 162°.

Upon the terrace, down about midway on the side of the mountain covered with this deposit, the principal active springs are now located, and here is pre-

sented another picture to the eye which transcends any description in words. The water is perfectly transparent, and down in the clear depths can be seen distinctly the minutest ornament upon the inner sides of the basin; and the exquisite beauty of the colouring and the variety of forms baffle any attempt to portray them, either with pen or pencil; various shades of red, from the most brilliant scarlet to light purple; yellow, from deep-bright sulphur through all the shades to light cream colour; and green of various shades. These springs also are full of a kind of vegetation, which under the microscope proves to be composed of diatoms, among which Dr. Billings discovers *Palmella* and *Oscillaria*. There are also in the quiet springs, and in the little springs that flow

from the boiling springs, great quantities of a fibrous, silky substance, apparently vegetable, which vibrates at the slightest movement of the water, and has the appearance of the finest quality of cashmere wool. A qualitative analysis made at the springs shows that the water contains sulphuretted hydrogen, lime, soda, alumina, and a slight amount of magnesia. Carbonate of lime predominates over all other elements in the deposits, and they may therefore be called calcareous springs.

There are two classes of springs in the Yellowstone valley, one in which lime predominates, in the other silica. With the exception of the White Mountain Spring in Gardiner's River, and one or two of not much importance, the other springs of the Yellowstone and Firehole basins are siliceous. They may be divided again into intermittent, boiling and spouting, and quiet springs. Those of the first class are always above boiling point during the period of action, but during the interval the temperature lowers to 150° . Those of the second are always at the boiling point, and some of them throw the water up two to six feet by regular pulsations. The springs of the third class may have once been geysers, but are now quiet, and have a wide range of temperature, from 188° to 80° . Where the temperature is reduced below 150° great quantities of the sesquioxide of iron are deposited by the water, lining the inside of the funnel, and covering the surface where the water flows. Taken in the aggregate, these springs have been in constant operation during our present period, and

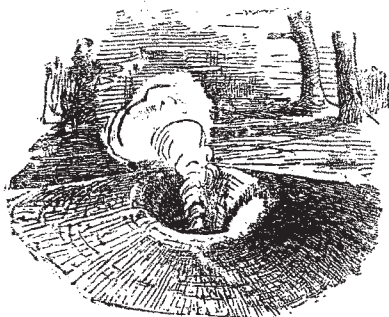


FIG. 4.—Hot Spring.

Mr. Hayden estimates that under favourable circumstances, at least six feet of this deposit have been precipitated within the space of one century.

We must omit an account of the basaltic columns in the cañons of the Yellowstone and Gardiner's river, and of the great cañons, falls, cascades, and other wonders of this unique region, and pass to the hot springs of the upper basin. A few springs are seen at the mouth of Tower Creek, at the lower end of the Grand Cañon; but it is not until we pass the range of mountains which forms the north wall of the upper basin, about twenty miles above the lake, that the great hot spring district of the Yellowstone commences. There is here an area, within the drainage of the Yellowstone, forty miles in length, and on an average fifteen miles in width, that either is at the present time, or has been in the past, occupied by hot springs. The old deposits cover the region, and here and there are groups of active springs—mere remnants of what formerly existed. The Grand Cañon is a deep channel 1,000 to 1,500 ft. in depth, carved out of the basaltic rocks, and hot spring deposits, and on the sides of the walls may be seen the irregular fissures which communicate from the surface with the heated interior. Resting upon an irregular surface of basalt are immense deposits of silica of all colours, every shade of red, yellow, and white. Much of the deposit is as white as snow.

On the west flank of Mount Washburne, in the north of

the area, there is a remarkable group of springs, in a constant state of action at the present time. Alum, sulphur, soda, and common salt, are found upon the surface in considerable quantities. Sulphuretted hydrogen is emitted from the spring in such quantities as to fill the air, rendering it oppressive with sulphurous odour. This group extends across the Yellowstone to the eastward for several miles. The springs, which are now in active operation, are only a few out of hundreds which once covered the entire area, but which are now dead or dying out.

Two remarkable groups deserve particular mention, the sulphur and mud springs, shown in Figs. 2 and 3. The largest group (see Fig. 2) is found on the east side of the Yellowstone, at Crater Hills, eight miles below the lake. This district covers an area of about half a mile square, and is sometimes called the "Seven Hills," from the fact that there are here several mounds of siliceous deposits from extinct springs, varying in height from 50 ft. to 150 ft. The old craters of dead and dying springs, and the immense quantity of the siliceous deposits, show that the present active springs represent only the last stages of what must have been at some period in the past a magnificent group. There are still numerous steam-jets, one of which, on the west side, produces a sound like that of a locomotive, which can be heard for a long distance. The surface is fairly riddled with little steam vents, and the crust sends forth a hollow sound beneath the tread; and on removing this shelly covering at any point, hot vapours come forth, while its under surface is encrusted with the most beautiful crystals of sulphur.

The springs at this point are either boiling, mud, or quiet springs. The principal boiling spring, which is in a constant state of ebullition, sends up a column of water 2 ft. to 4 ft.; has a basin about 15 ft. in diameter; and gives forth such a column of steam that it cannot be approached except on the windward side. But perhaps the most interesting objects here are the mud springs, which are of every size, from an inch in diameter to 20 ft. One of the largest is filled with fine light brown mud, which is in a constant state of agitation, the surface covered all over with puffs like hasty pudding. Others send forth a thud-like noise every second, with an impulse at long intervals that throws the mud up several feet. The water in the vicinity, as well as the mud, seems to be thoroughly impregnated with alum. In an adjoining valley are little mud or turbid water vents, which keep up a simmering noise, showing the nature of the earth beneath the crust.

Two miles above, on the same side of the Yellowstone, is the other group of springs, similar to those just noticed. Besides these are the geysers, to be alluded to presently. One of these is a true intermittent spring, and throws up a column of water 10 ft. in diameter, from 15 to 30 ft. high. The crater becomes filled with boiling water; suddenly immense columns of steam shoot up with a rumbling noise, the water overflows the basin, another column of water is thrown up for the space of 10 or 15 minutes, when it quiets down, and the basin is nearly empty. This operation seems to be performed about eight times in 26 hours. Upon the side of the hill bordering the river is one of the most terrific mud-cauldrons seen by Mr. Hayden during his visit. A large column of steam is constantly ascending, 500 ft. or more, from a deep funnel-shaped basin, 25 ft. in diameter; when the wind carries away the steam for a moment, the thin, black mud may be seen 25 ft. below the rim in the most violent state of agitation, with a noise like distant thunder.

On the shore of the south-west arm of the lake is an interesting group of hot springs, which extend along the margin, covering a belt about three miles long and nearly a mile in width. Many of these, which might be called pulsatory springs, are in a constant state of quite violent ebullition, but rise and fall every second or two, and with each pulsation throw out a quantity of water. Quite a

pretty, symmetrical, funnel-shaped crater is formed with a circular rim, varying from a few inches to several feet in diameter. Some of these funnel-shaped chimneys (see Fig. 4) extend out into the lake several feet, and the hot spring deposits may be seen through the clear depths for fifty yards. The same variety of colours, quiet springs, mud springs, old ruins, &c., that have before been described, occur here. No geysers have been observed, but the group of mud springs keep up a constant thud-like noise, which can be heard with great distinctness for half a mile. At Steamboat Point are two vents, which keep up a constant pulsatory noise like a high-pressure engine on a river steamboat; columns of steam are thrown out at each pulsation to the height of 100 feet or more.

(To be continued.)

NOTES

WE may hope that we and the public have now heard the last of the unfortunate Hooker and Ayrton dispute. We learn that Mr. Ayrton has expressed himself satisfied with Dr. Hooker's explanation of the "offensive" matter in his letter to Mr. West, and here the matter will probably rest. It would be more satisfactory to know that all probability of similar unpleasantness for the future had been removed, and that the Government recognises the principle that a servant selected to control a great scientific establishment must necessarily be entrusted with all the details of its management.

THE rejection, by the Committee of Recommendations of the British Association, of the resolution of Section D respecting the treatment of Dr. Hooker as Director of Kew Gardens, resulted in the sending up to a subsequent meeting of the committee of a more strongly worded resolution to the same effect, which was then passed, not only by the Committee of Recommendations, but by the General Committee.

AT the meeting of the French Academy on the 2nd instant, the President presented to M. Chevreul a medal which had been procured by a subscription among his *confrères*. M. Dumas in a speech "à la manière anglaise," as the President expressed it, touched upon the chief services rendered by M. Chevreul to science in acknowledgment of which this medal was presented to him. Each subscriber is to receive a copy of the medal, and according to a slip inserted in the *Comptes Rendus*, the subscription list is still open.

IT is with great regret that we have to record the death, at the early age of 38, after a long and painful illness, of Mr. John Cargill Brough, F.C.S. He was a man of most accomplished mind and great general culture, and had personally endeared himself to all his acquaintances. Mr. Brough had filled, for about two years before his death, the office of secretary and librarian to the London Institution in Finsbury Circus, and had brought new life into its management.

WE hear from Paris of the death, at the age of 42, of one of the most promising of the younger generation of French botanists, M. Gris. He had written largely on both systematic and physiological botany, and held the post of assistant in the botanical department of the *Jardin des Plantes*.

THE inaugural address of the winter session of the Birmingham and Midland Institute will be delivered on Oct. 7, by Canon Kingsley, who is the president for the year.

MR. G. F. RODWELL, F.R.A.S., &c., has just been appointed Lecturer on Natural Philosophy at Guy's Hospital, still retaining his position as science teacher in Marlborough College.

THE Royal Polytechnic Institution appears, under its new management, to be assiduously encouraging the cultivation of

Science. We have received a prospectus of classes held in the Institution in quite a number of branches of Natural and Physical Science.

WE notice from the *School Laboratory of Physical Science*, published in Iowa, U.S., that the total number of pupils who have attended one or more courses of lectures at the physical laboratory of the State University during the school-year of 1871-2, has been 340, representing all the departments of the University. Of these students, 270 have practised at the stands of the laboratory from two to ten hours a week each, and from the reports of the work done and the results, carefully calculated, of the examinations, it would appear that the teaching is varied and thorough. The high importance of laboratory work in the teaching of students is becoming more and more widely recognised in practice in the United States, and from this Report we learn that the great majority of the students themselves like the laboratory practice very much; those who do not, we are told, are those who are not fond of arduous mental work. As the opinion of the writer of the *Laboratory News* in the above work we quote the following note:—"One of the principal drawbacks to the perfect success of the Laboratory has been the admission of some students of advanced standing in the dead languages; we find these students almost invariably less careful in their work, and more hasty and illogical in their conclusions, than the regular beginners; they also have made the greatest blunders in calculation. As a result, such juniors have failed in competition with common sub-freshmen. I should not refer to these facts, if it were not so frequently asserted that the study of the dead languages constituted an auxiliary to the study of science."

THE Marlborough College Natural History Society has issued its Report for the half-year ending Midsummer 1872. In the Preface praise and blame are impartially dealt out to the members of the Society; the zeal and industry of individual members are commended in not undeserved terms; while the apathy and want of energy of the majority of the Society come in for severe censure. In the Botanical department some good work appears to have been done, and the president, the Rev. T. A. Preston, continues his *Flora of Marlborough*, the present instalment embrace the Calycifloræ. In Geology nothing has been done; in Ornithology a few of the members have shown active interest in "genuine Ornithology, not merely the taking of eggs, but observations of the birds themselves and their habits." The greatest triumph has been, however, in Entomology, where, thanks to the energy of two or three individuals, upwards of thirty moths have been added to the Society's list. Of the papers printed we may notice a useful one on Shells, by F. J. H. Jenkinson, and one on Thermo-Electricity and a new Thermo-Electric Battery, by Mr. Rodwell; others, however, are alluded to in the Preface. We cordially encourage the Marlborough College Natural History Society to continue its work.

MR. GOULD is now engaged on the preface to his great work on the "Birds of Great Britain," and will issue the last two parts, completing the whole, in 1873.

A VERY good "Flora of Liverpool" has been published by the Liverpool Naturalists' Field Club. The area included is within fifteen miles of Liverpool and two of Southport, and embraces some very interesting districts. The work has been performed by a committee of the society appointed for the purpose, with the assistance of amateurs and previously published records, which have all, when possible, been verified. It appears to have been carried out with great care, and some valuable notes are appended to the records of some of the species.

AMONG the most recently-published foreign flora we may note Dr. J. A. Knapp's "Plants of Galicia and the Bukowina," just published by Braumüller, of Vienna, in one thick volume.